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Comparative effect of different organic composts on growth and yield of French bean (*Phaseolus vulgaris*)

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Abstract
French bean (*Phaseolus vulgaris*) is a widely cultivated leguminous crop known for its nutritional value and economic significance. To enhance its growth and yield while adhering to sustainable agricultural practices, the use of organic composts has gained prominence. This study aimed to compare the effects of various organic composts on the growth and yield of French beans. The experiment was conducted in the rabi season of 2020-21 at Agronomy Farm (certified organic field) in College of Agriculture, Pune. There were ten treatment combinations which included various levels of FYM, mushroom compost and vermicompost along with a control plot laid out in randomized block design and replicated thrice. The impact of these composts on plant growth parameters, yield attributes and overall yield was carefully monitored and analysed. The results demonstrated that the application of 125% recommended dose of nutrients through vermicompost resulted in higher growth and yield attributes of French bean. These factors ultimately resulted in highest grain yield (14.93 qha^{-1}), straw yield (14.93 qha^{-1}) and harvest index (33.90). The application of 125% RDN through vermicompost also resulted in enhanced quality with higher protein content (24.13%) among all other treatments. These findings highlight the potential of organic composts to enhance French bean cultivation, with 125% RDN through vermicompost emerging as the most preferred option for sustainable and productive organic farming of French bean.

Keywords: French bean, FYM, mushroom compost, organic farming, RDN, vermicompost

Introduction
French bean (*Phaseolus vulgaris* L.) commonly known as rajmash, common bean, dry bean, pinto bean, field bean, navy bean and kidney bean and grown as premier pulse crop in the worldwide. It is newly introduced as non-traditional winter pulse crop in India with high yield potential of 2.5–3.5 t/ha (Kumar *et al.*, 2020) [11]. This crop is gaining importance in country for its dual uses both for green pods and dried grain. Beans are also known as the 'meat of the poor' due to their contribution in essential protein to the under nourished people (Yadav *et al.*, 2023) [31]. It is estimated that 100 g of green pods contain 1.7 g protein, 4.5 g carbohydrates, 221 I.U. Vitamin-A, 11 mg vitamin-C and 50 mg calcium (Dhillon *et al.*, 2018) [5]. French bean can be used as carminative, diuretic and emollient. It is also used in treatment of diabetes, diarrhea, dysentery and kidney problems (Supriya *et al.*, 2022) [20]. They are rich source of minerals, vitamins, fibre and contain a fair amount of protein as well as carbohydrates (Verma *et al*., 2023) [9]. Green pods contain high level of vitamin 'A' which is beneficial for the controlling night blindness in human being (Abrha *et al.*, 2016) [1]. In India Beans are cultivated on about 227.78 ha area with a production of 2276.95 MT ha^{-1} (Sulochna *et al.*, 2022) [19]. The lower productivity of french bean has been found mainly due to inadequate nutrition management (Jha *et al*., 2023) [9]. Due to poor nodulation, it is very inefficient in biological nitrogen fixation requiring higher dose of nitrogen fertilizer for enhanced productivity (Sharma *et al.*, 2018) [17]. Modern agriculture requires intensive use of chemical fertilizers, but price of inorganic fertilizers has gone up considerably, which in turn increased the production cost and decreased markedly fertility status of the soil (Verma *et al*., 2023; Porwal and Verma, 2023) [24-25-, 29, 15]. In view to maintaining the sustainable and health agro-ecosystem, it has become necessary to minimize the uses of chemical fertilizers by adding organic sources such as FYM, Compost, vermicompost, mushroom compost etc. Organic sources supply not only organic matter but also increase the fertility status of the soil (Verma *et al.*, 2023) [24-25, 28]. The organic manure slowly releases nutrient and has good effect both on instant crop as well as performance of succeeding crops (Pahade *et al.*, 2023) [13]. It also maintains the soil physical, chemical and biological characteristics and improves overall ecological balance of the crop production system (Tomar *et al*., 2023) [22-23].

Most of the micronutrients are highly essential for plant growth and development and increase bacterial activity of nodule in pulses (Yadav *et al.*, 2019) [32]. FYM is rich in organic matter and provides a balanced mix of essential nutrients, including nitrogen (N), phosphorus (P), and potassium (K). It also contains micronutrients and beneficial microorganisms that promote soil health (Swati *et al*., 2023; Jha *et al.*, 2014) [21, 8]. Slow-release nature of FYM ensures a steady supply of nutrients, promoting healthy French bean growth and improving resistance to disease and stress. The unique humic substances and growth hormones in vermicompost stimulate French bean growth, leading to increased yields (Verma *et al.*, 2023; Tomar *et al*., 2023) [24-25, 28, 22-23]. It also enhances disease resistance and nutrient absorption, reducing the need for chemical inputs (Wong *et al.*, 2020) [30]. Mushroom compost is a valuable source of organic matter and contains a range of nutrients. It's particularly valuable in providing stable organic matter for sustained nutrient release (Jasinska, 2018) [7]. The demand for organic French beans has surged in recent years as consumers become increasingly health-conscious and eco-aware. The effect of organic manures on the yield and productivity of French beans holds significant promise in meeting this demand while ensuring sustainable agricultural practices. Keeping the views of above aspects, the present research work was performed to find out the response of french bean (*Phaseolus vulgaris* L.) to different sources of organic nutrients like FYM, vermicompost, mushroom compost with the objective to study the effect of organic on growth and yield of French bean.

Materials and methods

Study site and climate

The field experiment was carried out during *rabi* season of 2020-21 at Agronomy Farm (certified organic field) in College of Agriculture, Pune (18°22' North latitude and 73°51' East longitudes, 557.7 m above MSL). The mean maximum and minimum temperature during the present investigation varied from 29.1 °C to 32.1 °C and 09.9 °C to 18.1 °C, respectively. The mean relative humidity during morning and evening hours was recorded between 86 to 96 percent and 26 to 56 percent, respectively. The highest mean amount of rainfall obtained was 36.8 mm.

Soil properties

The soil was clay loam with pH 7.78, with electrical conductivity of 0.45 dS/m, medium organic carbon (0.56%), low available nitrogen (176 kg/ha), medium available phosphorus (18 kg/ha) and high levels of potassium (382 kg/ha).

Experimental details

The experiment was laid out in Randomized Block Design with three replications. There were ten treatment combinations which included different sources of organic nutrients, T_1 (75% RDN through FYM), T_2 (100% RDN through FYM), T_3 (125% RDN through FYM), T_4 (75% RDN through Mushroom compost), T_5 (100% RDN through Mushroom compost), T_6 (125% RDN through Mushroom compost), T_7 (75% RDN through Vermicompost), T_8 (100% RDN through Vermicompost), T_9 (125% RDN through Vermicompost), T_{10} (Control). French bean variety *Phule rajma* (GRB-902) was sown on 20 November 2020 at the seed rate of 90 Kg/ha after treatment with *Rhizobium* and *PSB* culture @ 250 g 10 $kg^{-1}$of seed at the spacing of 45 cm x 10 cm. Crop management practices were carried out according to the recommended procedures. The nutrients were applied as per the treatments.

Observations

Observations related to growth parameters *viz*., plant height, number of branches, number of leaves, leaf area and different yield attributes and yield and protein content were recorded at specific stages of crop growth. The statistical analysis of data on various growth and yield characters studied in the investigation was carried out through the analysis of variance technique as described by Panse and Sukhatme (1954) [14]. The critical difference (C.D.) at 5 percent level of significance was given for those treatments which were found significant.

Results and Discussion

Growth parameters

Plant population

Plant count of french bean at initial stage and at harvest indicates the uniformity in the stand of crop. The initial and final plant population of french bean was not affected due to different treatments under study. The maximum initial (219400) and final plant count (216422) was observed under the treatment of application of 125% RDN through vermicompost, however, it was found non-significant with respect to other treatments (Table 1).

Plant height

Plant height in French bean was significantly impacted by all the treatments. The different levels of organic composts had a significant impact of the plant height at 42 DAS, 56 DAS and at harvest stage (Table 1). Highest plant height was obtained under the treatment of 125% RDN through vermicompost followed by 125% RDN through mushroom compost under all stages of the crop. The increase in plant height with 125% RDN through vermicompost might be due to more availability of nitrogen and essential nutrients to plants which supported the vegetative growth and also vermicompost contains more number of nitrogen fixing, phosphate solubilizing and other beneficial microbes, antibiotics, vitamins, hormones, enzymes etc., which have better effects on growth and resulted more plant height (Verma *et al.*, 2014) [29].

Number of branches

Number of branches were significantly impacted by all the treatments. The different levels of organic composts significantly increased the number of branches in French bean (Table 1). The highest number of branches were reported under the application of 125% RDN through vermicompost at 42 (4.71) and 56 DAS (6.78). The maximum number of branches per plant in this treatment might be observed due to more mineralisation of vermicompost and optimum availability of nutrients may lead to develop more number of branches. Similar results were also reported by Dash *et al.*, (2019) [4].

Number of leaves $plant^{-1}$

The number of compound leaves $plant^{-1}$ were increased with the advancement of crop age up to 56 DAS, while, it was

reduced at harvest due to senescence of leaves (Table 2). The application of 125% RDN through Vermicompost produced significantly a greater number of compound leaves plant^{-1} than all other treatments at 42 (14.50) and 56 DAS (20.01), which was at par with 125% RDN through FYM and mushroom compost at 42 and 56 DAS. The higher value of functional leaves with this fertility level might be due to supply of all essential mineral nutrients in a balanced amount which resulted in better growth and development. Vermicompost also features hormones that regulate and promote overall plant growth. These results are in agreement with results reported by Rehman *et al.*, (2023) [16].

Leaf area plant^{-1}

Leaf area per plant witnessed a progressive increase with the advancement of crop up to 56 DAS (Table 2). The treatment of application of 125% RDN through vermicompost recorded maximum leaf area (10.67 dm^2) plant^{-1} at 56 days after sowing which was significantly superior over rest of the treatments at all growth stages. The higher leaf area obtained in 125% RDN through vermicompost might be due to supply of essential nutrients in a balanced amount which resulted in better growth and development of plants. Similar results were reported by Ishtiyaq and Khan (2013) [6] and Verma *et al.* (2023) [24-25, 28].

Table 1: Comparative effect of organic composts on the plant population, plant height and number of branches of French bean

Tr. No.	Treatments	Plant population (ha^{-1})		Plant height (cm)				Number of branches (plant^{-1})	
		Initial	Final	28 DAS	42 DAS	56 DAS	At Harvest	42 DAS	56 DAS
T_1	75% RDN through FYM	213956	211466	17.24	20.86	28.31	25.52	3.80	4.50
T_2	100% RDN through FYM	216489	214000	16.81	23.87	30.47	27.02	4.34	5.14
T_3	125% RDN through FYM	213511	211022	17.66	25.77	32.95	30.50	3.92	6.22
T_4	75% RDN through Mushroom compost	218044	215555	16.88	22.38	29.06	26.21	3.84	4.54
T_5	100% RDN through Mushroom compost	216089	213600	17.50	24.41	30.72	27.21	3.90	5.21
T_6	125% RDN through Mushroom compost	213555	211066	17.70	26.29	33.56	31.44	3.97	6.51
T_7	75% RDN through Vermicompost	215933	213444	17.60	23.01	29.66	26.61	3.86	4.96
T_8	100% RDN through Vermicompost	214858	214823	17.62	25.52	31.27	27.85	4.00	5.28
T_9	125% RDN through Vermicompost	219400	216422	17.72	27.54	34.16	31.71	4.71	6.78
T_{10}	Control	215755	213260	17.20	19.70	24.65	22.53	3.21	3.48
S.Em. ±		13978	14100	1.14	0.92	1.04	0.98	0.25	0.24
C.D. at 5%		NS	NS	NS	2.74	3.08	2.9	NS	0.73
General Mean		215759	213466	17.39	23.94	30.48	27.66	3.96	5.26

Yield attributes

Number of pods plant^{-1}

The number of pods plant^{-1} in french bean were significantly influenced by different treatments (Table 2). Significantly maximum number of pods plant^{-1} (12.91) were obtained in 125% RDN through Vermicompost over all other treatments but it was found at par with the application of 125% RDN through FYM and 125% RDN through mushroom compost (Figure 1.). Better nutrient availability, microbial activity, and positive effects on soil structure, can contribute to a higher number of pods per plant in case of vermicompost as compared to FYM and mushroom compost (Chaudhary *et al.*, 2022) [2].

Number of seeds pod^{-1}

Significantly more number of number of seeds pod^{-1} were recorded in 125% RDN through Vermicompost (4.07), but was at par with the application of 125% RDN through FYM (3.78), 125% RDN through mushroom compost (4.00), and 100% RDN through vermicompost (3.46) (Table 2 and Figure 1.).

The increased in yield attributes with organic fertilization might be due to more availability of nitrogen to the growing plants. Secondly, this might be due to better and early development of strong root, which increased source capacity such as number of leaves, photosynthetic efficiency, translocation of photosynthates from source and its utilization towards yield attributing characters. These findings are in agreement with the results obtained by Choudhary *et al.* (2015) [3].

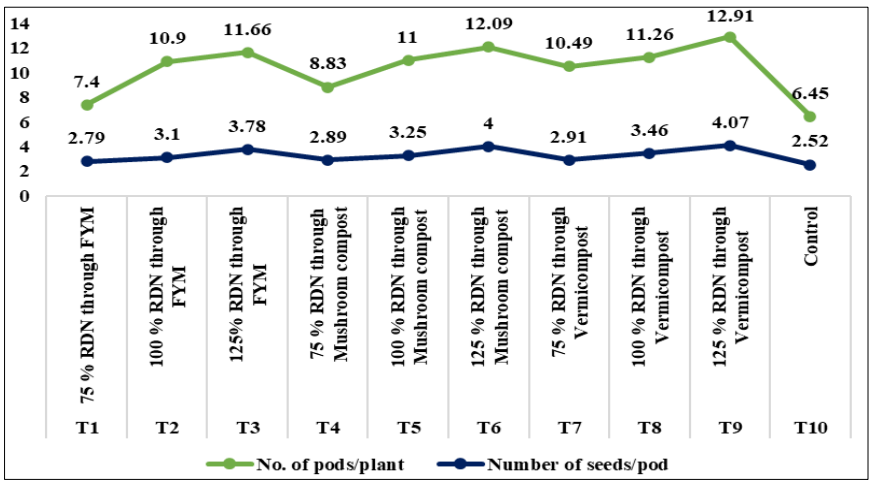

Fig 1: Effect of different composts on the yield attributes of French bean

Table 2: Comparative effect of organic composts on number of growth parameters and yield attributes of French bean

Tr. No.	Treatments	Number of leaves plant^{-1}			Leaf area plant^{-1} (dm^2)			No. of pods plant^{-1}	Number of seeds pod^{-1}
		28 DAS	42 DAS	56 DAS	28 DAS	42 DAS	56 DAS		
T_1	75% RDN through FYM	5.74	9.87	15.44	5.02	6.48	8.35	7.40	2.79
T_2	100% RDN through FYM	6.00	11.15	17.51	5.24	7.22	9.16	10.90	3.10
T_3	125% RDN through FYM	6.49	12.60	18.55	5.38	8.04	10.04	11.66	3.78
T_4	75% RDN through Mushroom compost	5.82	10.66	16.06	5.12	6.72	8.78	8.83	2.89
T_5	100% RDN through Mushroom compost	6.21	11.80	17.83	5.28	7.58	9.31	11.00	3.25
T_6	125% RDN through Mushroom compost	6.84	13.48	18.90	5.44	8.38	10.45	12.09	4.00
T_7	75% RDN through Vermicompost	5.97	11.01	16.82	5.19	6.91	9.09	10.49	2.91
T_8	100% RDN through Vermicompost	6.40	12.07	18.19	5.35	7.85	9.53	11.26	3.46
T_9	125% RDN through Vermicompost	7.05	14.50	20.01	5.47	8.55	10.67	12.91	4.07
T_{10}	Control	5.60	8.99	13.95	4.91	5.64	7.84	6.45	2.52
S.Em. ±		0.40	0.64	0.61	0.34	0.23	0.34	0.46	0.21
C.D. at 5%		NS	1.91	1.81	NS	0.69	1.18	1.37	0.64
General Mean		6.21	11.58	17.32	5.24	7.34	9.32	10.30	3.28

Yield

Seed and Straw yield (qha^{-1})

The application of nutrients through different levels of compost sources significantly influenced the seed and straw yield (Table 3). The seed (14.93 q ha^{-1}) and straw yields (29.11 q ha^{-1}) was found significantly more under the treatment of application of 125% RDN through Vermicompost than all other treatments while the lowest seed and straw yield was obtained in control (Figure 2). The application of vermicompost promotes plant growth and soil health which could have led to an increase in yield attributes and ultimately resulted in higher yields. These findings are in confirmation with Singh *et al.*, (2023) [18].

Harvest Index

The highest harvest index (33.90%) was observed with application of 125% RDN through Vermicompost among the all other treatments (Table 3). Lowest harvest index (33.16%) was recorded with control. These results are on same line with work done by Nasab *et al*. (2015) [12].

Protein content

The protein content in french bean grains as influenced by different levels of compost sources was recorded at harvest (Table 3). The protein content in french bean was found non-significant by application of different levels of compost sources. The application of 125% RDN through vermicompost recorded higher protein content 24.13%. However, lower protein content (19.63%) was observed in control. The application of vermicompost increases the availability of micronutrient in addition to the macronutrients. The micronutrients are actively involved in the protein synthesis inside plants, which could have resulted in higher quality in terms of protein content. Similar findings were also noted by Jinjala *et al*. (2016) [10].

Table 3: Comparative effect of different organic composts on the yield and quality of French bean

Tr. No	Treatments	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index	Protein content (%)
T_1	75% RDN through FYM	9.94	19.52	33.74	20.00
T_2	100% RDN through FYM	11.95	23.30	33.90	20.50
T_3	125% RDN through FYM	12.97	25.55	33.67	22.88
T_4	75% RDN through Mushroom compost	10.60	20.02	34.62	20.19
T_5	100% RDN through Mushroom compost	12.63	24.62	33.91	20.94
T_6	125% RDN through Mushroom compost	13.21	26.02	33.67	23.69
T_7	75% RDN through Vermicompost	11.60	22.62	33.90	20.38
T_8	100% RDN through Vermicompost	12.79	25.22	33.65	21.25
T_9	125% RDN through Vermicompost	14.93	29.11	33.90	24.13
T_{10}	Control	5.89	11.87	33.16	19.63
S.Em. ±		0.74	1.34	-	1.40
C.D. at 5%		2.21	3.99	-	NS
General Mean		11.65	22.78	33.81	21.36

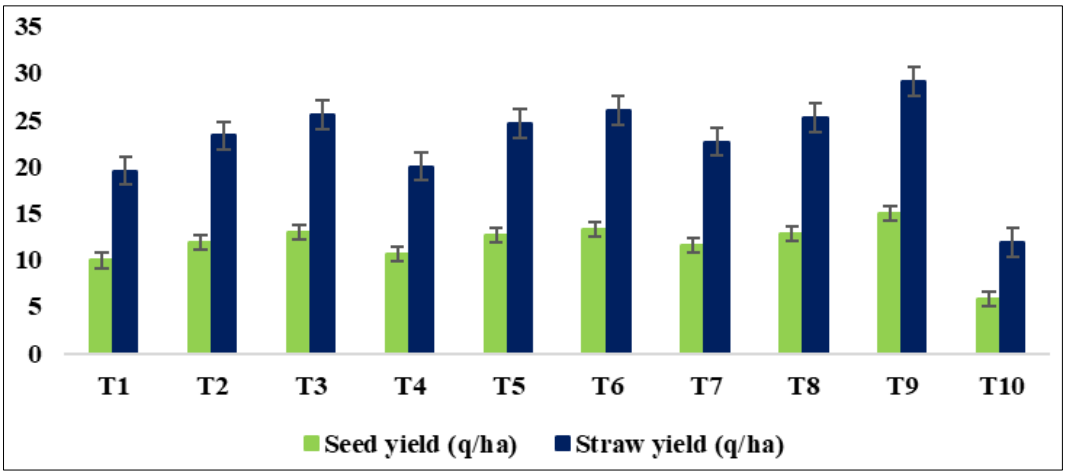

Fig 2: Effect of different composts on seed yield and straw yield of French bean

Conclusion

French beans are a significant crop due to their nutritional value and economic importance, and optimizing their cultivation methods is essential. The results showed that the application of 125% RDN through vermicompost increased the growth and yield of organic French bean. Therefore, based on the experimentation, it can be concluded that the application of 125% RDN through vermicompost could be recommended for increasing the yields of organic French bean.

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